



# **2013 New Jersey Traffic Monitoring Program**

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**In cooperation with:  
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## **CHAPTER 1: INTRODUCTION**

The Federal Highway Administration (FHWA) requires every state to submit a Highway Performance Monitoring System (HPMS) report annually that contains roadway characteristics and traffic data. This information is used in determining the funding for state highway projects. New Jersey Department of Transportation's (NJDOT) Traffic Monitoring Program supports the HPMS and internal sections such as Pavement Design, Operations, and Planning.

The Bureau of Transportation Data and Safety (BTDS) is responsible for administering NJDOT's Traffic Monitoring Program, which is in compliance with Federal regulations and guidelines. The program includes the collection, processing, summarization, and reporting of traffic count data along New Jersey's roadways.

NJDOT maintains a traffic monitoring program consisting of continuous and short-term elements. Both of these elements are conducted by BTDS in accordance with the FHWA Traffic Monitoring Guide (TMG) and the American Association of State Highway and Transportation Officials (AASHTO) Guidelines for Traffic Data Programs. The traffic counting program is designed to utilize, at a minimum, 48-hour short-term counts to produce estimates of Annual Average Daily Traffic (AADT).

Currently, NJDOT's Traffic Monitoring Program includes approximately 95 permanent continuous Traffic Volume Station (TVS) sites, 5,430 Short-Term Volume (48-hour) sites in a three-year cycle, and 90 permanent Weigh-in-Motion (WIM) System sites. In addition, approximately 400 "special" counts are performed each year as needed. These counts are normally requested by NJDOT Engineers for projects and/or investigations. These "special" counts can include volume, classification, or turning movement counts at intersections.

The traffic count data that is processed by the BTDS is provided to customers outside of NJDOT if requested. These customers include engineering consultants, educational research facilities, transportation planners, and other government agencies to name a few.

All processed traffic count data is available using an interactive map on the NJDOT's website: <http://www.state.nj.us/transportation/refdata/roadway/>

### **I. Responsibility**

BTDS is the central clearing point for maintenance and dissemination of traffic volume, classification counts and AADTs. All traffic count requests must be directed to BTDS to check availability of data before requesting new counts or hiring consultants.

Current traffic counts are available through NJDOT intranet network only and by using "Data Viewer 2" program. Prior year data are available to the public on the NJDOT webpage: <http://www.state.nj.us/transportation/refdata/roadway/>

This document shall be periodically reviewed and/or revised as deemed necessary by BTDS.

## **CHAPTER 2: PERMANENT (CONTINUOUS) MONITORING PROGRAM**

### **I. Background**

NJDOT's traffic monitoring program includes TMS sites along the roadway where traffic data is collected continuously 24 hours a day throughout the year, except during times of equipment failure or maintenance. The permanent locations are installed on all types of roadways ranging from Interstates to Minor Arterial Roads. The primary goal of the continuous count program is to assist in understanding the time-of-day, day-of-week, and seasonal travel patterns and to facilitate the development of seasonal expansion factors required to convert short-term counts to accurate estimates of AADT.

The BTDS currently maintains approximately 95 permanent TVS and 90 permanent WIM System sites statewide. This number increases and decreases based on construction projects and/or equipment failures.

### **II. Traffic Volume Station (TVS) Sites**

Each TVS location consists of two (2) vehicle detection loops imbedded in the pavement for each travel lane and a cabinet that houses the Automatic Traffic Recorder (ATR), modem, suppressors, and phone line/wireless hardware. Most of the ATRs that are being used throughout the state of New Jersey are Peek ADR models. All components of each counting site (loops, sensors, cabinet, ATRs, etc.) are tested and maintained by a consultant of the BTDS to ensure that the system is working properly and accurate traffic data is being collected.

The permanent sites are polled daily via modem and TOPS software by Peek. The wireless sites are polled using the TCP-Com software by TAL Technologies. The volume, speed, and classification data is reviewed by the BTDS for irregularities and missing data. This quality control check further ensures that accurate traffic data is being collected.

When problems in data are detected, an in-house technician will attempt to restore the site. If the technician cannot resolve the problem, the consultant to the BTDS is contacted for a service call. A technician from the consultant is then deployed to the site to troubleshoot the problem. If the problem cannot be resolved then the site is shut down until a permanent fix can be incorporated. For example, if the loops in one lane fail then the site will be put on the list for the BTDS's upcoming TMS Infrastructure Renewal Project for loop replacement. The TMS Infrastructure Renewal Project is a heavy maintenance project that will be explained later in this document.

Once the monthly traffic data has been checked and considered good, it is entered into the Traffic Data System (TRADAS) software for further processing. TRADAS is a traffic data analysis system that provides data warehousing toolkit for managing our traffic count data.

### **III. Weigh-in-Motion (WIM) System Sites**

The WIM program for NJDOT is maintained by the BTDS. Most of the WIM controllers used are iSINC Systems Electronics by International Road Dynamics, Inc. (IRD). The WIM sites are

set up to collect traffic data such as volume, classification, speed, and weight using a loop-piezo-loop-piezo-loop configuration. Vehicular classifications follow the 13-vehicle type guidelines outlined in FHWA's TMG. These sites are not polled like TVS sites; rather data is retrieved via modem and/or direct IP access daily. Traffic data gathered from WIM sites are used for pavement studies, capacity studies, freight studies, and enforcement. Classification and truck weight data is processed and submitted to FHWA each month and summarized annually through FHWA's VTRIS software. The BTDS also supports the Long Term Pavement Performance (LTPP) program providing data from the 10 Strategic Highway Research Program (SHRP) WIM sites. The traffic data for these 10 WIM sites are submitted to a FHWA consultant each month.

#### **IV. WIM Configuration and Installation**

NJDOT's standard WIM configuration consists of a loop-piezo-loop-piezo-loop installation in each travel lane. Although a standard WIM configuration includes two (2) loops, NJDOT installs a third loop to ensure that the system can function properly in the event of a single loop or sensor failure. NJDOT requires that loops and sensors have a warranty of 18 months and WIM controllers have a warranty of three (3) years from the vendor from the time of acceptance.

There are two (2) types of piezo sensors that NJDOT uses for the WIM systems. For most sites, the Roadtrax® Brass Linguini® (BL) class I axle polarized polyvinylidene fluoride (PVDF) WIM sensor made by Measurement Specialties, Inc. (MSI) are used. The Roadtrax® BL Sensor uses spiral-wrapped PVDF Piezoelectric film as the piezoelectric material. It can be installed directly into a slot cut into the road with a relatively small cross section for permanent applications. Its physical flexibility makes it easily conformable to any road transverse profile. According to its vendors, "the BL sensors' unique flat design results in a more accurate count by excellent signal to noise ratio (SNR) which has an inherent 10:1 rejection of road noise and reduction of "ghost axles" due to road bending, adjacent lanes and bow waves of approaching vehicles, conforming to the road profile giving a clean easy-to-read signal that translates into accurate vehicle count, speed and WIM data".

The other type of sensor is the Lineas® quartz piezoelectric Type 9195E WIM sensor made by Kistler Instrumente AG (Kistler). The Kistler sensor utilizes quartz crystal force sensing technology. It consists of an aluminum alloy profile in the middle of which quartz discs are fitted every 5 cm under pre-loading. This structure allows the measurement of vertical forces, such as wheel loads. The sensor is isolated from side forces by a special elastic material. It is decoupled from lateral forces and measures only vertical forces, so no ghost axles appear. On the other hand, 100% of the forces on the top of the sensor are measured, so there is no lost information. These sensors must be installed flush with the surface of any existing or new asphalt or concrete pavement surface with epoxy adhesive. Unlike the BL sensor, the Kistler sensor calibrations are not affected by temperature.

WIM installations must be performed in good weather (dry conditions during normal construction months) and the pavement must be in new or good condition. For install locations with poor pavement conditions, NJDOT requires a 2" mill/pave operation for a distance of 500' in the vicinity of the WIM system. The following are important requirements for WIM installations:

- a. Saw-cuts should be cleaned by pressure wash and dried prior to installation and grouting.
- b. Adjacent lane sensors shall be staggered.
- c. Ensure that the grout cures and is capable of supporting traffic within a maximum of 60 minutes from installation.
- d. Piezo sensors must be installed at a minimum of two (2) feet from cracks, joints, or saw-cuts if possible.
- e. Ensure that all loop detector, sensor, and lead in cable wiring are not spliced in the roadway and have sufficient length for termination at the controller in the cabinet.
- f. When the sensor grout is cured, grind it flush to the roadway surface using an angle grinder.

In areas of new pavement operations, the loop detectors shall be installed in the base course and sealed before the installation of the surface course. In areas of existing pavement, the pavement shall be saw-cut in the surface course. Loop detectors are 6'x6' in size and consist of four (4) turns of wire in each location.

All roadway sensors are installed in a saw-cut in the surface course. The sensors must be long enough to cross the entire length of each travel lane and be active across that distance. Temperature sensors (for BL sensors) are installed with a saw-cut in the shoulder area adjacent to the cabinet. The temperature range for the temperature sensor should be between -40 °C to +110 °C.

All equipment needed to operate a WIM site shall be housed in a controller cabinet adjacent to the roadway or in the median where applicable. The cabinet will include the following components:

- a. WIM controller.
- b. Communication equipment (dial-up modem or NJDOT Ethernet set-up).
- c. Power and communication surge protection.
- d. Backup power supply.
- e. Operating software.
- f. All necessary interconnecting cables and miscellaneous materials to make an operational system.

Once the system has been installed and is up and running, NJDOT requires that a calibration be performed before acceptance. Calibration procedures will be discussed later in the chapter.

## **V. System Maintenance**

The BTDS has a consultant under contract that provides labor and materials to perform routine preventative maintenance/inspection and on-call repairs for all WIM and TVS sites. WIM and TVS preventative maintenance and inspections should be done at least once a year and include the following procedures:

- a. Electronic testing of in-road loops and sensors.

- b. Maintain and clean system components.
- c. Visual inspections of the infrastructure including:
  - Loops and Sensors (cracking, missing grout/epoxy, etc.)
  - Junction Boxes
  - Roadway condition
- d. Vegetation control around the cabinet.
- e. Maintain controller and meter cabinets (vacuum clean, replace filter, etc.).
- f. Maintain a log of visits and what was performed.
- g. Maintain software (provide upgrades and support as necessary).

On-Call repairs are performed when the BTDS notifies the consultant that TMS equipment is malfunctioning after an in-house technician has identified the problem. The consultant shall begin on-site repairs within seven (7) working days for non-emergency repairs and within 48 hours for emergency repairs. Examples of non-emergency repairs include replacement of backup batteries and fuses. Examples of emergency repairs include nonresponsive communications, lane(s) not collecting data, and nonresponsive sensors/loops.

## **VI. Data Downloading**

Raw data is downloaded on a daily basis remotely from the BTDS office. In cases where communications have been temporarily lost due to modem/telephone failures, data can be retrieved from on-site using a laptop connection. Although data is downloaded remotely every day, not every site is downloaded every day. This is because of the number of WIM sites and the time it takes to download data. On average, one site is downloaded at least once a week each month. The raw data files are stored, by day of the month and site, on the BTDS' network drive.

Before any data is downloaded on each site, BTDS staff views live traffic to ensure all lanes are working and classifying properly. If problems are found, corrective action is taken to fix the problems. If the problems cannot be resolved then a service call is provided to the maintenance consultant.

The data is downloaded in two different ways depending on how the site is set up to communicate. These ways are through a dial-up connection via 56k modem or through the NJDOT's fiber optic network. Both communication options are performed using the Procomm Plus Terminal software.

## **VII. Data Processing**

Once a whole month's of data is downloaded, the monthly processing procedure begins. The processing procedure includes a number of checks in regards to volume, classification, truck weights, and speed. The primary software programs used by the BTDS are IRD's iSINC office and iANALYZE.

A monthly report and FHWA TMG records are produced each month for each site. The monthly report includes a class by day of the month summary, class by front axle weight summary, class by gross vehicle weight (GVW) summary, and a site summary. IRD's iSINC office is the

primary software used to create the reports and records. In select instances for special reports, volume by direction for example, IRD's iANALYZE is used. iANALYZE is also used to create specific reports requested by NJDOT engineers, planners, or outside customers.

The class by day of the month summary is reviewed for irregularities in volumes and classifications for each lane of travel. Volumes are checked for consistency throughout the week. Normally, weekends and holidays include less traffic than a typical weekday. The exception is on routes that motorists use to commute to the New Jersey shore for weekend and holiday getaways during summer months. These routes may experience higher volumes on the weekends and/or holidays. In cases where there is irregularities in volume data (no data for the day or inconsistent data), these days are considered "bad" and they are removed from the classification and weight cards. Classification data is also checked in this summary report. NJDOT uses the FHWA 13 Class Scheme (Class 1-13 with Class 14 being unclassified vehicles). Quality checks for classification include checking for a high percentage Class 3 vehicles (near equal, equal to, or greater than Class 2), Class 5 vehicles greater than 5%, and Class 14 vehicles greater than 2%. When Class 3 vehicles are irregular for certain days, those "bad" days are removed from the classification and weight cards. In the event that the Class 5 and/or Class 14 thresholds are exceeded for a lane, that direction is considered "bad" for classification and weight. Therefore, the direction in question is used for volume only. Appendix A includes a graphic illustrating the FHWA 13 classification scheme.

Front axle weights for Class 9 trucks are verified for each travel lane. Whether a truck is empty or loaded, its front axle weight should range from 8,000 to 12,000 pounds. The front axle weight summary table for each lane is reviewed to ensure that the majority of Class 9 trucks fall within this range. If the range is shifted below 8,000 pounds, then the lane is considered to be under calibrated. Lanes that are over calibrated see a shift in range that is over 12,000 pounds. Lanes that are under or over calibrated are noted not to be used in VITRIS processing. In addition, the calibration and auto calibration factors for these lanes are reviewed via remote connection to the WIM controller. Adjustments are made to auto calibration and/or calibration factors based on the front axle weight ranges. Once adjustments have been made, the live traffic is viewed to ensure that the vehicles are weighing and classifying properly.

Next the GVW summary for Class 9 trucks is reviewed for each travel lane. Most sites have two (2) peaks in the GVW distribution. The first peak represents unloaded trucks, which should fall in the range from 25,000 to 35,000 pounds. The second peak, which ranges from 70,000 to 80,000 pounds, represents a typical loaded Class 9 truck. If the summary shows that the peaks are shifted from these ranges it is most likely due to the site being out of calibration. A second check performed with the Class 9 GVW is an examination of the number (and/or percentage) of vehicles that are heavier than 80,000 pounds. It is particularly important to look at the number and percentage of Class 9 vehicles that weigh more than 95,000 pounds. If the percentage of overweight vehicles, particularly vehicles that weigh more than 95,000 pounds, is high, the controller's calibration is questionable. This check is performed partly because when many Piezo sensors begin to fail, they generate an almost flat GVW distribution. This results in an extremely large (and inaccurate) ESAL computation for a given number of trucks. It is unusual for Class 9 trucks to carry such heavy loads. In most cases, trucks legally carrying these heavy weights are required to use additional axles, and they are classified as Class 10 or higher and do



not appear in the Class 9 GVW summary. While illegally loaded five-axle trucks may be operating at the site in question, most illegally loaded trucks do not exceed the legal weight limit by more than several thousand pounds, and the number (or percentage) of these extremely high weights is usually fairly low. Thus, it is assumed that high percentages of extremely heavy Class 9 trucks are a sign of calibration or operational problems. Troubleshooting for GVW irregularities is similar to the troubleshooting for front axle weights. The auto calibration and calibration factors are reviewed for inconsistencies for lane in question and adjustments are made remotely if applicable.

The site summary is reviewed for average GVW and average ESAL factors for each lane. These numbers are tabulated and entered into a spreadsheet on a monthly basis. Each month is compared to the previous month to ensure that the weights and factors have not shifted significantly. If they have shifted significantly, it could be an indication of the site being out of calibration.

FHWA TMG records produced each site include “C” cards for classification data, “W” cards for weight data and a “V” for volume count. “C” cards summarize classification data by hour for each lane. These cards are checked to ensure that there are no continuous rows of zeros (“0” rows). If rows of zeros are found during a certain day for a lane and cannot be explained then that day is considered “bad” and must be removed from the card for that direction of travel. The “W” cards summarize the weight data for vehicle Class 4 to Class 13. Checks for “W” cards include cutting out GVW weights ranging from 0 to 4,999 pounds. Once the “C” and “W” cards have been checked then it is sorted by lane and loaded to the VTRIS data base for further check and processing. In cases where classification for a certain direction was considered “bad”, “V” cards are created for that direction. “V” cards summarize the volume by day for each lane. Similar to classification checks, “V” cards are reviewed to ensure that there are no “0” rows. If rows of zeros are found during a certain day for a lane then that day is considered “bad” and must be removed from the card. Once the “V” card has been checked then it is sorted by lane and loaded to TRADAS.

The BTDS participates in the Long Term Pavement Performance (LTPP) program. The LTPP program was established to collect pavement performance data as one of the major research areas of the Strategic Highway Research Program (SHRP). BTDS’s participation includes 10 LTPP locations at eight (8) current WIM sites. Classification, weight, and volume data is processed for these sites in the same manner as described above and then submitted to the LTPP’s regional consultant each month. Since 1991, the Federal Highway Administration (FHWA) has continued the management and funding of the program.

## **VIII. System Calibration**

Before a site is calibrated, it must be tested to show that the WIM components have passed testing requirements. These tests include:

- a. Measuring the inductance of each loop. Ensure that inductance is within a range consistent with four turns of loop detector wire. The ratio of loop detector inductance to detector lead inductance must meet controller system vendor requirements.

- b. Measuring and ensure that each piezo axle sensor produces a signal in conformance with manufacturer and controller system vendor specifications.
- c. Ensure that roadway sensors send signals to the on-site controller and the on-site controller converts those signals into useable data. Verify data through site observation using the real time review capabilities of the system. Ensure the loops and weight sensor combination record correct vehicle classification and axle counts.
- d. Ensure that signal from in-pavement temperature sensor are accurately received by the system electronics in accordance with electronics system vendor specifications.

After the testing procedure is completed then the initial calibration can be performed. A Class 9 vehicle (three-axle tractor and two-axle semi-trailer) is used for the calibration. The truck must have an air-ride suspension and is in good mechanical condition. It is loaded with a non-shifting load so that the gross weight of the tractor-trailer combination is between 75,000 and 80,000 pounds.

The calibration truck is weighed on a certified, multi-draft public scale. the weights of the steering axle, drive tandem axles and trailer tandem axles as well as the total gross weight of the combination is recorded.

The calibration truck shall be driven over each lane for minimum of five (5) times and the axle and GVW illustrated by the WIM system is recorded by each working sensor for each pass. The average values among the five (5) passes are used to calculate the new calibration factor for each working sensor.

Following the adjustment to the system by entering the new calibration factors for each working sensor, the calibration truck shall be driven over each lane a minimum of another (3) times and the axle and GVW as determined by the WIM system is recorded by each working sensor for each pass. Average values among these three (3) passes are used to confirm the calibration factor for each working sensor. After calibration, the average values recorded by the WIM system should be within 10 percent of each axle weight (average axle weight of each axle group); and within five (5) percent of the GVW of the combination of the weights recorded at the public scale. If either value is not within these tolerances, the calibration factors are calculated, entered into the WIM system, and the validation procedure as described above is repeated.

If the system cannot be properly calibrated after two iterations of calibration factor updates, it could be an indication of defective sensors, WIM electronics, of pavement condition. The calibration process is then repeated once corrective actions have taken place.

The WIM system is then monitored for 14 consecutive days. The data produced during this period is reviewed in accordance with the LTPP QA program. Once it has been determined that the data has been recorded properly and the system components are working on a continuous basis within the required specifications, then the system is accepted.

## **CHAPTER 3: SHORT-TERM MONITORING PROGRAM**

### **I. Background**

The short-term traffic monitoring program for NJDOT is maintained by the BTDS. Short-term coverage counts are conducted on roadways throughout the state to provide the geographic coverage needed to understand the traffic characteristics of the state roadway system. The traffic counting efforts associated with this program are conducted by three (3) different consultants in accordance with the HPMS, TMG and NJDOT Guidelines for Data Programs. Currently, the short-term monitoring program includes approximately 5,430 48-hour sites that are counted in a three-year cycle period. In addition, approximately 400 “special” counts requested by NJDOT engineers are performed each year as needed. Special counts can include volume, classification, or turning movement counts at intersections. Seasonal adjustment factors derived from the permanent continuous counts are used to adjust the short-term counts to arrive at AADT estimates.

### **II. Standard Procedures**

These standards shall apply to all short-term traffic monitoring activities conducted by or for the NJDOT and/or its agents with the intent of guaranteeing the raw data gathered from traffic monitoring activities undertaken by NJDOT and those undertaken as part of any contractual agreement involving funds administered and/or provided by or through the FHWA and/or NJDOT is in conformance with these standards established for traffic data collection.

Equipment Calibration/Testing of ATR and Automatic Vehicle Classification (AVC) equipment must be conducted to ensure that the equipment is recording data accurately. Each machine (ATR and AVC units) shall be tested *at least once* every three (3) years. The equipment test site(s) shall have the following characteristics:

- a. Traffic volume shall be greater than 5,000 vehicles per day per lane.
- b. Roadway shall be straight with a grade less than three (3) percent.
- c. Road surface shall have no ruts greater than ¾” with no severe potholes or other serious surface distress.

There shall be no traffic signals, stop signs, or any impediment to continuous traffic flow.

ATR and AVC equipment using axle detectors (road tubes) for volume counting and vehicle classification shall be installed and hourly data shall be collected for a continuous two (2) hour period. A manual classification count will be conducted at the same time and the results will be compared. A maximum error of 10 percent for axle detections, and an accurate classification of 90 percent of each class of vehicles are required for acceptable performance of each unit of equipment.

Maintenance records shall be maintained and provided upon request.

The following test documentation shall be supplied prior to the collection of any data:

- a. Test site location and characteristics.
- b. Testing procedure.
- c. List of equipment by device type, manufacturer, model, serial number, achieved accuracy (volume and/or classification), and dates of current and last tests.
- d. Installation and operating procedures.

The duration of all ATR and AVC volume and classification counts shall be a minimum of 48 continuous hours. The entire 48-hour period shall fall within a normal workweek (12:01 PM Monday through 12:00 Noon Friday) or a normal weekend (12:01 PM Friday through 12:00 Noon Monday). The weekend period is acceptable only for the purpose of identifying or monitoring recreational or retail traffic. Weekend data shall not be used to estimate AADTs. No part of any 48-hour count used for AADT estimation shall contain data collected within 36 hours of any extended weekend resulting from a Federal, State, or local holiday unless the purpose is to study holiday traffic. All non-typical conditions shall be avoided.

All data shall be collected by direction with a 15-minute recording interval. Recording shall begin on the hour and end on the hour so that data files do not contain partial data for any hourly subtotal. In the event that intervals less than one (1) hour are collected, summaries in that interval shall **not** be submitted to BTDS and they shall not be considered as part of the 48-hour count duration.

To ensure consistency in automatic traffic data collection, installation procedures shall be defined, documented, and provided by all traffic monitoring agencies, firms, and agents.

Pneumatic road tubes shall be installed at a right angle to traffic across a lane or lanes. The outer end shall be plugged. Clamps shall be affixed at the outer end, at the outside edge of pavement, at the inner edge of pavement, and at the outer edge of a paved shoulder. Tubes shall be affixed taut enough to guarantee minimum motion when crossed by vehicles. BTDS strongly recommends mastic tape spaced at 12 to 24-inch intervals to minimize motion of tubes.

When utilizing two (2) tubes in the classification mode, both tubes shall be of the same age, type, length, and tension. The tubes shall be spaced according to the specific roadside unit requirements. Free-flow conditions are required for effective automatic vehicle classification. Where conditions are not free-flow, or speeds are lower than 25 miles per hour, manual vehicle classification counts (see below) are required to verify the accuracy of the electronic AVC monitoring.

On multi-lane roadways with one-way volumes greater than 10,000 AADT, portable loops and electronic axle sensors *must* be employed to collect classification data. On each side of the roadway, no more than one lane shall be monitored for vehicle type classification per AVC recorder and pair of tubes. On two-lane roads, one AVC recorder and pair of tubes shall be installed on each side of the roadway. On four-lane roads with a suitable median, one (1) additional four-channel AVC recorder or two (2) additional two-channel AVC recorders shall be installed in the median to classify traffic in the lanes adjacent to that median.

Pneumatic road tubes shall conform to the American Society for Testing and Materials (ASTM) “Standard Specifications for Pneumatic Tubing for Roadway Traffic Counters and Classifiers”.

Recording units may be located on either side of the lane being monitored. The units shall be chained to secure objects and be relatively free of risk from damage by vehicles, flooding, or other hazards. In no case shall recording units be attached to or set on barrier curbs. Excess tubing shall be routed away from the roadway, coiled, tied, and kept clear of potential snagging or damage.

Whether the sensor is pneumatic or electronic, the installation site shall be carefully selected. No sensor shall be placed in proximity to an intersection, driveway, or other vehicle maneuvering location where travel is not at a right angle to the sensor.

No sensor shall be installed where the roadway surface has ruts greater than ¾” or severe potholes.

When monitoring sites in residential neighborhoods, particular attention must be paid to minimizing the effect of noise from traffic traveling over pneumatic tubes. Tubes should be placed as far as possible from dwellings and securely fastened to avoid “bounce”. Mini-tubes may be used if accurate counts can be obtained. If the site must be relocated to another block, the Project Manager must be notified.

Upon completion of each monitoring session, and when the recorder is removed, all sensors, clamps, nails, and other installation devices shall be removed from the site and reused or properly discarded. Mastic or other adhesive tape may be cut and left affixed to the roadway. However, pneumatic tubes and other sensor devices must be removed from the roadway (including the roadside area) and taken away from the monitoring site.

All traffic monitoring locations shall be identified by unique traffic station identification numbers. Prior to undertaking any traffic counts, BTDS shall be contacted to coordinate activities and to obtain traffic station identification numbers.

Each count shall be described through the use of the NJDOT Standard Route Identifier (SRI) including route number and name, link limits, milepost, direction of travel, functional classification, municipality, and county.

All short-term count data, regardless of the equipment being used, shall be reported to BTDS Project Manager in the standard FHWA Record Type 3 format for Traffic Volume and Record Type C for Vehicle Classification Records. Classification counts shall be based on the “Scheme F” vehicle classification categories as defined in the TMG with Class 14 for unclassified vehicles. Transmittal shall be confirmed through the NJDOT Project Manager and/or his/her designee. Count acceptance shall be determined based upon the successful processing and editing of the raw count data. Counts that are not acceptable for any reason shall be redone and resubmitted to NJDOT.

3341400001A121201011001780027300140000890004900038000600007400131002790044400  
5730077300738008540084100854007780071700571004880033500258001980  
3341400001A111201011002560039600257001720013400100001360016200249003850052200  
6900078100772008610083700867008080076300664005560045500355002710

C340000155212010100000340000000023000110000000000000000000000000000000  
000000000000000000000000

C340000151212010100000480000000034000140000000000000000000000000000000  
000000000000000000000000

C340000155112010100001670000000122000420000000001000000000000000000200000000  
000000000000000000000000

C340000151112010100002030000000154000480000000001000000000000000000000000  
000000000000000000000000

For counts that are to be used to develop 24-hour volumes, AADTs and Design Hourly Volumes (DHVs), a minimum of eight (8) hours of data shall be collected between 10:00 AM and 6:00 PM. One hundred percent of every hour shall be counted except for two (2) 15-minute breaks and one 30-minute lunch period. These breaks shall not be taken during the peak periods, at the beginning of the first hour, or at the end of the last hour, and shall be noted on the data recording sheet.

Counts used for AADT or DHV estimation shall not contain data collected within 36 hours of any extended weekend resulting from a Federal, State, or local holiday unless the purpose is to study holiday traffic. All known or observed non-typical conditions shall be avoided.

Manual classification counts, as with automatic equipment, shall be based on the “Scheme F” vehicle classification categories.

All count and classification data shall be submitted to BTDS. Count summaries shall be provided in 15-minute intervals as well as one (1) hour totals. Classified intersection counts shall report volumes by classification plus total vehicles per interval. Intersection turning movement counts shall be in an EXCEL spreadsheet format.

Counts shall indicate the project number, SRI including route number and street name, municipality, county, date of count, day of week, start time, weather, times of breaks, and the name of the enumerator(s). If NJDOT has pre-assigned a station identification number, it shall also be indicated on the count record.

### **III. Geographic Information Systems (GIS)**

GIS plays an important role in the location and date of each short-term count. Prior to using GIS software, all short-term counts are entered into a Relationship Database Management System (RDBMS). This database stores information on each count including such attributes as location (milepost and latitude/longitude), type of count, functional class of roadway, latest AADT (by direction if applicable), and date of last count. Based on which County or region will be studied, the BTDS can extract information from the RDBMS and plot the short-term count locations on a map using ArcGIS software.

The GIS software is then used to visually review the locations of the short-term counts along the roadways. Mapping count locations is a critical step in determining when each location should be counted, as well as, determining the coverage of different road functional classes. For example, the GIS can be used to illustrate what locations within a selected period of years are located in a 1-mile buffer. If a count location in question is adjacent to another count on the same road or same functional class within this buffer, it can be determined that the location is considered “covered” for that cycle year and can be counted in the next cycle year.

## **CHAPTER 4: DATABASE MAINTENANCE**

Short term count and continuous data are processed with the TRADAS software. The software processes, analyzes and generates classification and volume data. It is a self-contained package consisting of an Oracle database and a processing application.

A second database called TMSCENTRAL is used as the backbone for the bureau's Intranet and Internet applications. TMSCENTRAL is an in-house designed program that supports our internet search engine "Data Viewer" and raw data upload. TMSCENTRAL stores directional AADTs, Hourly Peak Volumes (short term counts only), and hourly per lane vehicle classification data from continuous (permanent) stations. TMSCENTRAL contains location details including linear (Standard Road Identifier SRI and Mile Post) and spatial (longitude and latitude) coordinates. In addition, every location is linked with a set of images. Below is the list of entities contained in the TMSCENTRAL database.

D\_cnty – NJ county list

D\_consultant – list of consultants performing a count

D\_func\_class- Functional Class list

D\_direction – list of directions

D\_muni – list of the NJ municipalities

D\_station\_type – list of different types counting stations, i.e. continuous volume, weigh-in-motion, volume 48hrs, turning movement.

Regions – list of geographical regions in which the New Jersey is subdivided. It is used to develop seasonal and axle correction factors.

Stc\_station\_info – table that contains information about a counting station location

Stc\_events – table that contains multiple counts for a single station.

Stc\_station\_photos – table that stores file names of images for counting stations.



## **CHAPTER 5: TRUTH-IN-DATA NARRATIVE**

The "Truth-in-Data" narrative describes the basis of the derivation of K-factors, D-factors, percent single unit commercial vehicles, and percent combination commercial vehicles.

As each 48-hour short-term count file is processed, the highest hourly volume (averaged over the weekdays included in the count) is identified. After application of the monthly pattern factor and the axle correction factor that produce the AADT estimate, the percentage that the high hourly volume is of the estimated AADT is calculated to estimate the K-factor. The percentage of that high hourly volume traveling in the higher direction is the D-factor.

Seasonal factors are used to compensate for the monthly variation of traffic throughout the year. There are 12 seasonal factors per factor group per year (one per month). In order for a site to have a seasonal factor calculated for a given month, the site must have an AADT for the traffic year and a monthly ADT (MADT) for the month in question. Seasonal factors are calculated by the following equation:

$$Seasonal\ Factor_{month} = \left( \frac{AADT}{MADT_{month}} \right)$$

Factor Group – it is a geographical region selected based on the similarity of traffic conditions. In New Jersey there are 5 pattern groups:

- Group 1 – Interstate Urban (Functional Class 11)
- Group 2 – All Urban (Functional Class 12 to 19)
- Group 3 – All Rural (Functional Class 2 to 9)
- Group 4 – Interstate Rural (Functional Class 1)
- Group 5 – Recreational Areas

The calculated AADT estimate is derived in the following manner: The hourly volumes recorded in each direction over the minimum 48-hour period are averaged and totaled to produce an average weekday volume. This is multiplied by the appropriate monthly pattern factor (seasonal adjustment factor). For example, the seasonal adjustment factors applied to calendar year 2011 counts were based on permanent and major station counts throughout calendar year 2010. The seasonal adjustment factors are based on continuous and major station monthly average weekday volumes (non-holiday Tuesday, Wednesday and Thursday) as compared to the calculated annual average daily traffic volume for each station. Major stations are monitored for one week during each month. The stations are generally grouped in the following categories:

- a. Urban Interstates;
- b. other Urban routes;
- c. other Rural routes;
- d. Rural Interstates; and
- e. Recreational

If any station's monthly factor exceeds 1.2 for three or more months, the station is considered “ungrouped”.

For the traffic volumes measured by the use of road tubes, the volume estimates are further adjusted by use of Axle Correction Factors. Axle correction factors are developed from the classification data. Individual factors are developed for each functional classification. This classification data was supplemented with manually collected classification data from ten (10) locations in the Delaware Valley Regional Planning Commission (DVRPC) area (Counties of Burlington, Camden, Gloucester, and Mercer) for an 8-hour period (10:00 AM to 6:00 PM) for one day each season (four sessions per station). Continuous classification data was obtained from over 70 WIM and continuous AVC stations.

Group factor approach is a methodology where roadway sections with similar travel patterns and roadway functional classification are grouped together. Continuous classification count locations are selected from each grouping of roadway sections and adjustment factors are developed for data collection sites within each group. Adjustment factors for each group are averaged and used to adjust short-term data that are collected at locations within the group.

Beginning in 2013, using 2012 data, the new methodology using New Jersey's 5 regions group factor will be used in calculating seasonal and axle correction factors from continuous counting stations (WIM and TVS) and major short term count locations. Instead of one table using statewide factors, each region will have a table of factors to use.

Average truck percentages are determined from continuous WIM and AVC sites for each functional class of roadway in each of the 5 regions.

Short-term classification and truck counts are collected at a limited number of sites. The short-term counts are converted to Annual Average Daily Truck Traffic (AADTT) using the truck factors obtained from the continuous WIM sites.

FHWA vehicle classes 4 to 7 are considered as Single Unit Trucks and classes 8 to 13 are Combination Trucks.

## **CHAPTER 6: INFRASTRUCTURE RENEWAL PROGRAM**

Continuous truck weight and vehicle-type classification data collection are fundamental components of the congressionally mandated Traffic Monitoring System. Data obtained through these systems is also essential to the Pavement Management System, particularly with the implementation of the new Mechanistic Empirical Pavement Design Guide. To ensure all WIM and TVS systems are working properly, the BTDS manages a federally funded construction contract called the TMS Infrastructure Renewal Program. This program is used to maintain, upgrade, and install new WIM and TVS sites.




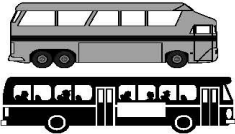



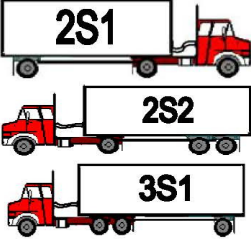
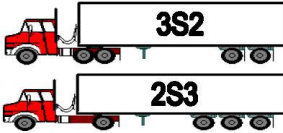
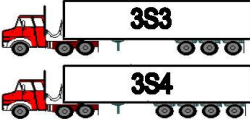



Repairs to existing sites performed by the selected contractor normally consist of, but are not limited to, replacement of defective piezo sensors, loop detectors, defective temperature sensors, or installing non-invasive traffic monitoring technology. Complete installations consist of installing piezo sensors, loop detectors, foundations, junction boxes, conduits, electrical service, telephone service, cabinets, and other related construction activities as may be required to install a completely functional Traffic Monitoring System, WIM, TVS and Virtual Weigh Station (VWS).

A VWS is a sub-system of a WIM System that weighs and measures vehicles automatically and provides vehicle record information to an authorized user either locally or remotely for enforcement of commercial vehicle and traffic data analysis. The vehicle record information is provided via a wireless network communication service. There are 20 WIM sites that were upgraded to VWS used in conjunction by state police for truck weight enforcement. VWS operates with other components of a WIM including the WIM axle weight sensors, inductive loops, controller electronics and cabinet.

Installation and maintenance contract for WIM and TVS sites is done in accordance with the provisions of the NJDOT Specification for Road and Bridge Construction and available on the NJDOT webpage:

<http://www.state.nj.us/transportation/eng/elec/ITS/itsenglishjuly2001/>

## APPENDIX A: FHWA 13 CLASS SCHEME GRAPHIC

 FHWA Class 1 Motorcycles	 FHWA Class 2 Passenger Vehicles
 FHWA Class 3 Other Two-Axle, Four-Tire Single-Unit Vehicles	 FHWA Class 4 Buses
 FHWA Class 5 Two-Axle, Six-Tire, Single-Unit Trucks	 FHWA Class 6 Three-Axle Single-Unit Trucks
 FHWA Class 7 Four or More Axle Single-Unit Trucks	 FHWA Class 8 Four or Fewer Axle Single-Trailer Trucks
 FHWA Class 9 Five-Axle Single-Trailer Trucks	
 FHWA Class 10 Six or More Axle Single-Trailer Trucks	 FHWA Class 11 Five or Fewer Axle Multi-trailer Trucks
 FHWA Class 12 Six-Axle Multi-trailer Trucks	 FHWA Class 13 Seven or More Axle Multi-trailer Trucks